

ON COSTAL AND THORACIC RESECTION FOR PYOTHORAX.¹

WITH SPECIAL REFERENCE TO THE EXPLORATORY METHOD.

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At the Ninth Congress of Internal Medicine, Ziemssen and Ewald said, "Old cases of pyothorax should not exist; and when they did, the attending physician should be held responsible for their existence." This may be a rather severe verdict, still, in a way, it expresses the truth.

The histories of old pyothorax observed by me during a period of twenty-two years in New York City invariably reveal the fact that thorough evacuation of the pleural effusion was omitted at an early stage, that is, until after the expansion power of the lungs was materially impaired.

In the great majority of these cases aspiration therapy was continued for weeks before radical steps were taken. In some cases a simple incision had been made, in a smaller number procrastination went so far as to look for healing by the development of a so-called empyema necessitatis, and in a few cases surgical therapy was not considered at all because the pyothorax was supposed to be of a tuberculous nature.

It may safely be assumed that in all these cases, except those of tuberculosis, recovery could have been expected after timely and thorough evacuation, *i.e.*, by primary rib resection. And while the prognosis of tuberculous pyothorax is grave, yet recovery took place in a number of cases treated by extensive thorax resection, as will be shown farther below. Similar principles apply to the treatment of pyothorax in which other

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pathological conditions prevailed, like emphysema, for instance. The presence of complications of this kind naturally delays the healing process, even after early resection. There are several cases of this kind on record. Under such circumstances, which must be regarded as exceptional, early resection even of the thorax wall may be indicated.

As a rule, the expansion power of the lungs can be estimated at the time of the primary rib resection. If the case is of long duration, if the history points to the presence of complications, and if the diaphragm fails to rise and the pulmonal pleura approaches the thoracic wall to a limited extent only, the resection of a small piece of rib is insufficient, a multiple resection being then imperative. And if the costal pleura appears to be fibrous, thoracic resection should be substituted for simple costal resection. If the condition of the patient does not permit of so extensive a procedure, the typical primary rib resection should be performed with a view to undertake the thoracic resection a week later, when the patient has become more resistant.

Early primary rib resection is advisable for many reasons. The main one is that it is unsurgical to treat abscess of the pleural cavity on principles which differ from those governing us in the treatment of other abscesses. Modern surgery treats abscess cavities by free exposure and gauze packing. While it is not denied that a cure can be effected by aspiration, especially if the effusion contains no solid elements, it remains a hazardous procedure as long as the presence or absence of such elements cannot be determined.

In 55 per cent. of my cases solid masses were found in the abscess cavity. These could certainly not be aspirated. Now, if any of our diagnostic means could enable us to know whether such were or were not present, it might appear more justifiable to recommend free opening only in cases where solid masses are present, and to try aspiration when they were absent. But as long as we possess no other means, mechanical or speculative, to make this differentiation, save by making a free opening, we have to choose the method which guarantees the

removal of the solid masses; and if a case which would have recovered by simple aspiration should undergo the more radical procedure of free opening, it will certainly get well just the same.

The simplicity of the aspiration technique is tempting. It is natural, therefore, that it finds its most enthusiastic advocates among the large contingent of the surgical amateurs who enjoy the prerogative that they never need the aid of a surgeon. They are generally the same who pride themselves with seeing all their cases of appendicitis recover "without being interfered with by the surgeon." When they aspirate, they draw as much pus as they can; the patient is then greatly relieved, and is so enthusiastic in praising this simplified treatment, that it would be simply impossible for a surgeon to persuade him to undergo such a "mutilating operation" as free opening. If the pus accumulates again, the patient gladly submits to a second and even to a third or fourth aspiration, because "a stab with a needle is no operation." But the solid masses in the pleural cavity cannot be withdrawn through the caliber of the aspirating needle, nor will they be absorbed. So the aspiration is repeated until much precious time is wasted, the patient becoming emaciated and the lungs contracted. Then, as a last resort, a free opening is made, which at this late stage often will not serve to prevent the fatal outcome. From this experience the aspiratory enthusiast concludes, of course, that free opening, particularly the resection treatment, yields a bad prognosis, as he, at least, "never saw a good result from it." These same operators would give up aspiration could they once see the solid masses in the pleural cavity. But unfortunately they never see an opened thoracic cavity, at least not at the early stage of pyothorax, and so they naturally conclude that such masses exist only in the imagination of some surgeons.

Aspiration should be reserved exclusively for exploratory purposes, for the cure of serothorax, and as a preliminary procedure where patients are extremely exhausted. In such cases, however, the apparatus of Bülow should be used.

As to the definition of serothorax, it may be said that such

effusions must be called serous which, although containing a small amount of pus cocci, still show the light color and the characteristic consistency; while pus represents a yellow, thick, homogeneous fluid. In practice, the differentiation should be made only macroscopically.

In 1879 Baelz advised the combination of aspiration with irrigation. The wish was the father of the thought, and it was certainly a splendid idea to try to wash out the solid particles from the pleural cavity. But these masses are unfortunately of too large size to be forced through the cannula of a trocar, so that this method, which was received with great enthusiasm, dropped into disuse.

The so-called Bülow's or suction method deserves attention. It is far superior to simple aspiration in that it aims to prevent refilling of the pus after aspiration. The technique of this method consists in introducing through the intercostal space a large trocar, from which the stylet is withdrawn, only the cannula remaining.

After a rubber drainage tube is pushed forward through the cannula into the pleural sac the cannula is removed. The tube, which must remain *in situ*, is then fastened to the skin with adhesive plaster and connected by a glass cannula with a long rubber tube. The rubber tube ends in a glass vessel filled with bichloride of mercury, where it is kept by attaching a piece of lead to its end. The glass vessel may be represented by a bottle, which the patient can carry around in his vest-pocket. The advocates of this method claim that a permanent evacuation proportional to the expansion of the lungs is thus achieved.

Brilliant as this method appears on a superficial contemplation, it has many and great disadvantages. First of all, the same objection as against simple aspiration must be raised, namely, that the solid masses cannot be removed by suction any better than by simple aspiration. Even the advocates of this method admit that the drain is oftentimes obstructed by fibrinous coagula. Fever is nearly always present on account of pus retention. It is but a small consolation that, by the introduction of instruments and frequent irrigations, this per-

petual obstruction can be removed, and that in the course of time the solid masses become liquefied.

Another very disagreeable feature of this method is that the drainage tube becomes loose in the wound-canal, which will finally suppurate, and then, of course, the seclusion from air is no longer hermetic. When the adhesive plaster becomes loose, the drainage tube is apt to fall into the cavity, and the only way to remove it is by free opening. I have seen a number of cases in which such accidents happened after Bülow's method was used.

It is furthermore to be remembered that all such patients require much more careful watching than those under radical treatment. In fact, the control must be so strict that it can be well carried out only in a hospital.

In cases where the intercostal space is narrower than usual, a small drainage tube can sometimes be introduced only with difficulty and after much annoyance to the patient; so the suction method should be reserved for very emaciated patients, and then used only as a temporary resort.

Simple incision through the intercostal space has still many advocates, for the reason that in the majority of cases it is undoubtedly effective. It is also claimed that a small incision, which permits of the introduction of a small-sized drainage tube, fully answers the purpose of evacuation and of drainage, and that any general practitioner could make the incision; while resection is regarded as a difficult operation, which would require the well-trained skill of a specialist. Resection should be reserved, therefore, as a last resort only in cases where, after several months of unsuccessful treatment after the incision method, the ribs have approached each other to such a degree as to render the drainage imaginary.

Modern surgery, on the contrary, prescribes that the opening into an abscess cavity should be made as broad as possible. The cavity should be exposed to such an extent that it can be inspected thoroughly, that its walls can be palpated, and that its lining membrane as well as necrotic tissue (the latter often being present) can be removed. It is only after such rigorous

procedures that the surgeon is satisfied that the evacuation is thorough. The wound discharge will be scant, and will be taken up by the gauze introduced into the cavity. No retention is to be expected, and, as a natural sequence, a perfect and quick recovery may be looked for. It would not be expected that a surgeon should "lance" an abscess anywhere else, or introduce a drainage tube, the use of which would also imply the necessity of daily irrigations. And why should a pyothoracic cavity be treated on different principles from other abscesses?

Again, after simple incision the field of operation cannot be inspected at all. No method except resection enables the surgeon freely to introduce his finger, which procedure renders examination of the cavity possible and at the same time permits of thorough evacuation. Only if the intercostal space is very wide, which is never the case in children and seldom in adults, can the surgeon's finger be introduced; and if the opening permits of this, the finger is greatly restricted in its exploratory motions, and only small solid masses can be removed. Large masses will remain. Adherent clots cannot be detached from the pleura, nor can very large masses of them be reduced inside of the cavity, so as to make it possible to wash them out by a subsequent irrigation. So these masses have to undergo decomposition, retention of pus, of course, always being present, and are dissolved or liquefied under constant febrile elevations, when, at last, they may be washed out,—provided the patient holds out so long.

As regards the alleged difficulty of resection, the surgeon performs many an operation more difficult than that of rib resection. Interference with the intercostal artery happens much more frequently in simple incision than in resection, on account of the situation of the artery below the inner surface of the rib. In resection, the incision is made only as far as the periosteum. So far there are no vessels of any importance. Then the further procedures can be carried out with blunt instruments. The tissues in which the artery is embedded are pushed aside, so that it can be easily seen and avoided. If it chances to be severed during incision, resection must be done

at once; and in such case, if the operator is very nervous, the patient may bleed to death before it is completed. Fatal hæmorrhage from the intercostal artery after incision is reported from several clinics (Billroth). If, however, such an accident should happen after the resection of the rib, the artery can be readily caught. Often the ribs move together after simple incision. Then the further introduction even of a small drainage tube becomes impossible. This condition prevails in the majority of cases. In fact, it represents the omnipotent *vis medicatrix naturæ*, the effort of nature to diminish the extent of the cavity. But, unfortunately, the intended remedy in such cases is nothing less than a prevention of the cure, because it obstructs the opening.

So far there is no method which shows with any degree of probability before operation whether such fibrinous or cheesy masses are present. All we know is that the streptococcus has a predilection for solid masses. Yet in some of my own cases streptococci have been found where no solid masses were present. A large opening, which can be insured only by the performance of a resection, allows inspection and palpation of the cavity and represents the only means to diagnose the presence of the solid masses. So long as we can get no information about this most important point by other methods, resection should be preferred for this reason alone.

Even if performed late, in an emaciated patient who has been weakened under expectant treatment, whose lungs have lost their contractility after so long a period of compression, while the functions of the neighboring organs are impaired by the long duration of their displacement, resection will often still avert the fatal result. There are in fact no contraindications for rib resection in pyothorax, while in those unpardonable cases of long standing, where the patient has become weak and cyanotic, the pulse being small and frequent, a preliminary aspiration may be done for temporary relief, and resection on the following day or later.

In all cases of pyothorax, therefore, no matter how desperate they may sometimes appear, the resection of a piece of rib

should be performed. Cures have been effected even in cases when there seemed to be no gleam of hope. Even when the tarrying policy, "*la médecine expectante*," had caused amyloid degeneration of the liver, ascites, etc., entire restoration to health has sometimes followed the resection treatment. Amyloid degeneration on this basis must not be regarded as a hopeless condition, especially in children.

In tuberculous cases cures are reported by Schede, Gueterbock, Küster, Rydygier, Hofmohl, Th. Weber, Koranyi, and myself, after very free rib resection. In view of the absolute hopelessness of tuberculous pyothorax, if left alone or treated medically, even a much smaller percentage of cures, as reported, would very positively indicate the resection treatment. It would also be of great benefit if such patients were operated upon much earlier, the chances being then much more favorable.

While primary miliary tuberculosis as well as pyothorax, caused by the perforation of tuberculous cavity into the pleura, gives a very poor prognosis, those cases in which the pleura has been infected from tubercular lungs show a considerable percentage of cures. Mixed infection is generally present in cases of this variety, the pneumococcus, staphylococcus, and streptococcus being also found.

While the tubercle bacillus was not found in the pyothoracic effusion of a considerable number of these cases, the presence of tuberculosis could be well proven by other than bacteriological means of investigation. In other words, the absence of the tubercle bacillus does not prove the absence of tubercular disease. So, as long as our diagnostic means in this direction are not absolutely reliable, the surgeon will always be on the safe side by operating upon every pus accumulation in the pleural sac, whether tubercular or not.

In double tuberculous pyothorax, of course all radical steps should be omitted.

The persistence of a thoracic cavity, whether it be simple, complicated, or tuberculous, must necessarily lead to a fatal end. The better the patient is situated, the longer the inevitable outcome may be postponed, but this is only a question of

time. It is difficult to understand, therefore, why expectant treatment is still preferred to timely resection.

As said already, the pulmonic tissues as well as the thoracic parietes lose their elasticity. After a long continuance of the inflammatory irritation, the pleuræ become thickened and infiltrated, so that the costal pleura finally becomes so hard as to seem like an osseous coat-of-mail. At the same time the persistent and abundant suppuration causes amyloid degeneration.

In those exceptional cases where the lungs have not completely lost their elasticity, an effort may be made with the apparatus of Perthes, which permits of continuous aspiration. But, as a rule, the pulmonic pleura becomes immovable, the lungs fixed and inexpandible; while at the same time the chest wall does not show any tendency to collapse. To enforce this collapse of the chest wall has been the aim of the various operative procedures advised ever since Gustav Simon made the first suggestion of multiple rib resection. While the merit of Esthlander, whose name is generally identified with this method, should not be underestimated because he developed the principles of Simon, the latter is, as the record clearly shows, the father of the ingenious idea.

The practical advantages of the Simon method are small, however, as their indications are limited, for the reason that the pleuræ are left untouched. Even Küster and Esthlander, who extended the operation, did not recognize in the thickening of the pleura the main obstacle for the healing process. They maintained that the pleura should be a *noli me tangere*, and that the pleural wheals were useful and necessary for the formation of adhesion between the pleura. The genius of Schede recognized this fact on which the principle of resection of the thorax is based; in other words, that since the pleuræ represent a coat-of-mail as firm as osseous tissue, they must share the fate of the ribs, *i.e.*, removal. Simon's original idea thus formed the stepping-stone for the more perfected method of Schede.

This principle is represented in practice by the exposure of the cavity through an incision reaching from the fourth rib,

running in a curve downward to the posterior axillary line on a level with the tenth rib, and then up again in a curved direction on the medial side of the scapula. In this way access is gained to the largest cavities.

While the principle of Schede, as far as the removal of the pleural tissue is concerned, must be held as irreproachable, there are some objections to his technique. First of all, the fact must be considered that most of the cases of old pyothorax do not need so severe a procedure; in other words, that Schede's method reaches beyond the mark. It is, in fact, in its general execution one of the severest of operations; and it offers no little danger to the patient who is already weakened through prolonged debility. It is also to be remembered that it is performed not only by the skilful hands of its inventor, but also by the average surgeon, and *si duo faciunt idem, non est idem*.

As a matter of fact, modern surgery does not present a suitable field for the development of typical operations. Even the fundamental principles of incision for amputation, sacred for thousands of years, and formerly the *pièce de résistance* of the old masters, have become shaky, the surgeon generally adapting himself to the individuality of the case. And if we consider that old pyothoracic cavities show a many-sided picture which even the all-penetrating Röntgen rays cannot faithfully portray, it becomes evident that a typical method of resection is only advisable in a minor number of cases. Of course, we can measure the extent of the cavity by pouring in fluids, and the Röntgen rays give us an inlook after the infusion of iodoform glycerin which increases the shadows. Skiagraphy also proves uniform opacity in necrosed conditions of the pleuræ, while fluoroscopy shows the mobility of the ribs considerably interfered with. But all these indications, while of great academic interest, do not give the data for a detailed plan of resection.

Probing is extremely uncertain, because the cavity is generally irregular; the fistulous tracts are generally twisted and often of a meandering nature. The probe thus being arrested by projecting pseudomembranes, it is an altogether unreliable

indicator of the topography of the cavity. The consideration of the deficiency of our exploration methods has led me to employ methods of procedure which are intended to fit each individual case; in other words, to perfect the plan of operation while operating. A large exploratory incision should precede the operation, the details of which will then be dictated by inspection and palpation.

Exploratory incision in diseases of the pleura was performed by me with good results in June, 1894. (See "Exploratory Pleurotomy and Resection of Costal Pleura," *New York Medical Journal*, June 15, 1895.) In the first case observed by Dr. I. M. Rottenberg, of New York City, fibrous degeneration had taken place on both sides of the pleura as a consequence of a long-standing inflammatory process. Considerable respiratory disturbances were caused, which could not be explained satisfactorily. The exploratory resection of a rib in the region of dulness, proceeding slowly and gradually, not only discovered this condition, but also remedied it by removing the enormously thickened layers of the pulmonic pleura.

The experience gained in this case induced me to try the principle of gradual and methodical procedure in cases of old pyothorax, and with gratifying results, as described in an essay on Pyothorax, in the *International Medical Magazine*, January, 1897.

The *modus operandi* of this exploratory method consists in resecting the rib which lies approximately in the middle of the roof of the cavity, regardless of the pleural fistula, as illustrated by Case I, for instance. The fistula is utilized for the passage of a sound, but during the operation itself it is avoided, as in old cases osseous projections are formed around the fistulous tract which make the direct method difficult (see Fig. 5), most of them being more easily reached from the side. The pleura underlying the resected rib is now incised. By means of a lateral incision enough room is gained to inspect a large part of the cavity and to palpate the cavity walls. The use of the pleural speculum originally advised for primary resection is not necessary in such cases (Fig. 1).

If the cavity is small and the patient is in a fairly good condition, which is exceptional, then the next two or three ribs are resected from the vertical incision in proportion to the extent of the cavity beneath, while the soft parts are held back with sharp retractors. The costal pleura is then excised by means of a blunt-pointed knife. If the fibrous tissue is very hard, then the lumen of the intercostal arteries is so much diminished by compression that the hæmorrhage can be regulated by temporary pressure. Then soft parts and ribs may be divided at the same time. Although this formation of wheals is to be most expected in very advanced cases, one should not rely too much upon such helps of nature, but make sure by means of a temporary prophylactic ligature en masse. This is carried out best by the aid of a large aneurism needle. In more extensive cases the ribs are divided successively in the same manner; the presumptive length of each piece is ascertained by palpation as it is incised. Palpation also tells whether the pleura below the ribs is still elastic or must also be sacrificed. The incision of the soft part proceeds likewise, which results in a very irregular looking flap. But no particular attention needs to be paid to the shaping of the latter, as it must depend more or less upon that of the cavity. Accordingly, cross-incisions may also be made. If a portion of the scapula is found to be in the way it is excised.

The muscular flap set free by the resection of the scapula can be utilized for the purpose of partially filling up the underlying cavity.

A mentionable point, to my knowledge not yet presented in literature and not of rare occurrence, is the concave arrangement of the lung surface which overbridges a certain amount of the cavity. The lateral parts of the pulmonary pleura succeed here to attach themselves to the costal pleura, fibrous adhesions holding them there. But the middle portion does not follow, and now it represents the floor of the cavity over which the approximated sides form the roof. The picture of this remarkable condition can be compared with that when one presses in the lung surface with the thumb so far that the sides of that segment of the lungs collapse in a ring around it. Then it re-

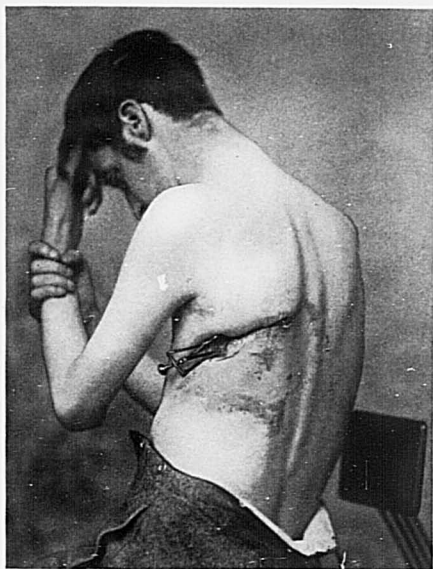


FIG. 1.—Pleural speculum in situ.

sembles the longitudinal fold formed of the gastric wall which is united in Witzel's gastrotomy over a tube, so that a canal is made of it.

Special caution is necessary at the beginning of the operation. If in a case of this kind we were to incise directly without first exploring the cavity thoroughly after the resection of the first rib, then we should injure the lungs. But if we have located the place of the thin portion where the pulmonary pleuræ join, then it is possible to finish the process by blunt dissection after having carefully divided the fibrous tissues. The lateral portions then gape apart and the circular cavity is transformed into a flat one. Partial decortication is indicated in such a case. It appears that the right half of the lung is particularly prone to this sort of adherence, due perhaps to the presence of the middle segment, which seems to have a desire to heal in the wrong direction.

The fact that the scapular region is the predominant seat of old cavities explains some of the technical difficulties incurred in the attempt to produce an artificial collapse of the chest wall. While in 21 per cent. of my cases the anterior, and in 8 per cent. the lateral, thoracic region was affected, the posterior area figures with 71 per cent. If it is considered that the posterior chest wall excels in firmness and rigidity, it will be understood that its collapse is produced with more difficulty than in front. Consequently, cavities show a much greater tendency to establish themselves there. It is evident that the artificial collapse can only be effected if all obstacles are removed; in other words, if the portion of the scapula which may prevent access to the underlying cavity is also eliminated.

Similar principles apply to the apex of the pleural cavity, which is not at all touched by Schede's procedure. Just as in the scapular region it is only the removal of the cavity roof which makes a cure possible. The vicinity of the subclavian vessels produces a risk of drawing the upper ribs into the field of operative measures. The following procedure has done me much service in the resection of that point of the costal dome which covers the pleural cavity. I would like to recommend it on account of its simplicity and comparative safety, and

because it can be performed to a limited as well as to a large extent, just as the individuality of the case demands it.

With the arm at right angles, the incision is led close to the lower border of the pectoralis major muscle in a horizontal direction till it ends at the lower part of the anterior margin of the deltoid muscle. The muscles are then dissected back superiorly until the axillary region is free. The vessels and muscles are grasped by strong blunt hooks and pulled upward. Sometimes separation is possible only by the aid of lateral incisions into both pectorales. Thus the vessels are temporarily put *hors de combat*, and the ribs can be removed according to the indicated principles. If it is very difficult to reach the first rib by means of the pectoro-axillary incision, then the clavicle is to be resected temporarily.

The decorticated flap is then trimmed and placed on the pulmonary surface of the pleura. If pieces of the pulmonary pleura have been removed, agglutination is much easier. In my aforementioned monograph (January, 1897) I laid particular stress upon the fact that the callous areas of the pulmonary pleura should also be removed. This is not easy in debilitated patients. But whenever possible, the operation should be finished in one séance, for a later supplementary operation always partly destroys the fruits of the first. Of course, in a case of doubt, we rather sacrifice them for the patient's safety.

This kind of decortication we gain by flat, saw-cutting incisions similar to the method of preparing microscopical sections. The principle is akin to that of the temporary resection, followed by decortication of the pulmonal pleura, as advised by Fowler and Delorme. But it is not practised methodically as advised by these authors, and only as the necessity arises after the exploratory section, and then as a supplement to the resection of the costal pleura.

Great credit is especially due to Fowler for the ingenuity of his procedure and "it would be a consummation devoutly to be wished" that the lungs would follow the wish of the operator. But clinical experience shows that it is only in a small series of cases that the lungs expand fully after the pulmonal pleura is mobilized. Therefore in most cases a resection of the

chest wall must be added to decortication of the pulmonal pleura.

Garré (XXVII Kongress der Deutschen Gesellschaft für Chirurgie, 1898) tried decortication repeatedly, but always with an unsatisfactory result. He also believes that the results of the procedures are entirely due to the interference on the chest wall.

As I see from a later publication, Jordan (*Beiträge zur klin. Chir.*, Band xxxiv) and Krause (the same, Band xxiv, v. 1) likewise report results from this combination.

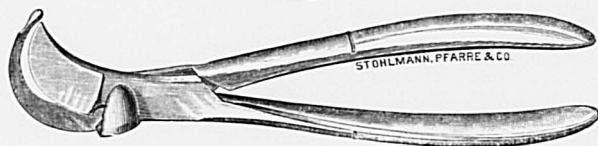
For dividing the rib, I use an annular periostome (Fig. 2) and an elevatorium rib-shears (Fig. 3). The first is a sort of

FIG. 2.



aneurism needle, but flat, and formed to embrace the rib, as I might say. After the dissection of the periosteum it serves as a retractor. It is combined with an elevator. The shears can be taken apart, so that both halves can be applied separately as

FIG. 3.



in the obstetrical forceps. (The instruments are pictured in the *New York Medical Record*, May 19, 1894, and the modifications in the *Journal of Surgical Technology*, December, 1900.)

The same principle was obviously applicable to the treatment of lung abscess, and therefore I recommended the exploratory pleuro- and pneumotomy in cases in which other methods, especially aspiration, gave no results. (See, on the diagnosis and treatment of abscess of the lung, *New York*

Medical Journal, August 28, 1897.) Later, Tuffier reached the same conclusion. Of course, the use of the Röntgen rays has facilitated the process of locating the abscess. But the carrying out of the operative plan will have to shape its course in ac-

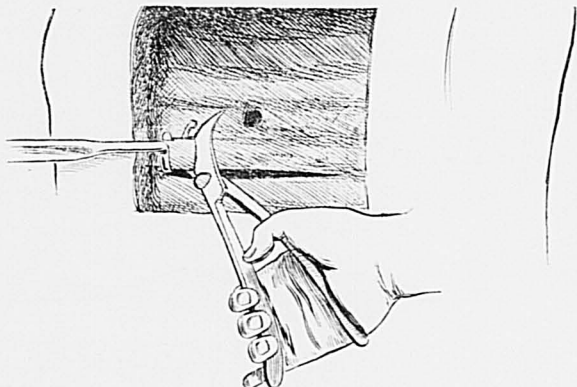


FIG. 4.—Annular periosteome retracting soft tissues while the shears divide the rib.

cordance with the principles pointed out. The cavity is packed with iodoform gauze. Immediately after the operation this is done tightly, later on loosely. Then drainage tubes, enveloped by iodoform gauze, may also be used. Thus irrigations are not only rendered unnecessary, but are in fact harmful.

During the after-treatment stress is to be laid upon early gymnastics, which favor expansion of the lungs. To this end I recommend dumb-bells and practice on a bugle. The regeneration of the resected ribs is illustrated by the Röntgen rays (Fig. 5).

As illustrated in my previous essay (*International Medical Magazine*, January, 1897), the Röntgen rays offer splendid means of studying the various stages of bone proliferation after resection.

The photographs (Fig. 6) (a) represent the results of such processes, as, for instance, showing synostosis around the drainage tube so that a complete bony canal was formed; (b) shows synostosis without channel formation, and (c) illustrates

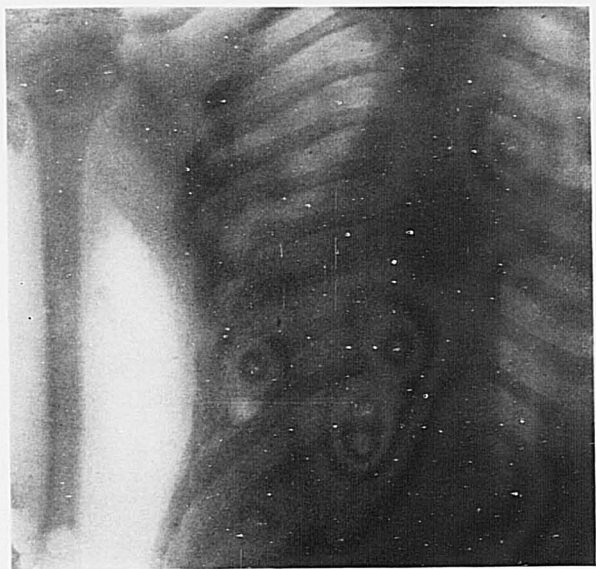


FIG. 5.—Regenerative process after resection of the fifth, sixth, seventh, and eighth ribs and of a portion of the scapula.

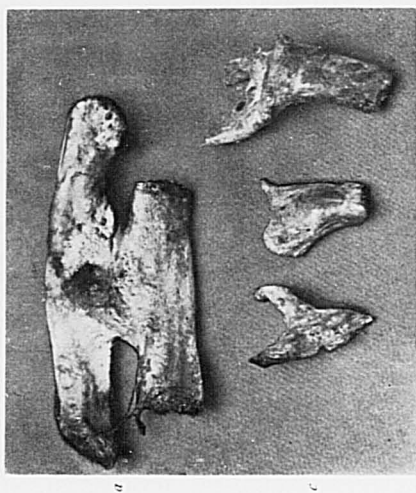


FIG. 6.—*a*, Synostosis around drainage tube; *b*, Synostosis without channel formation; *c*, Stalactite formations.

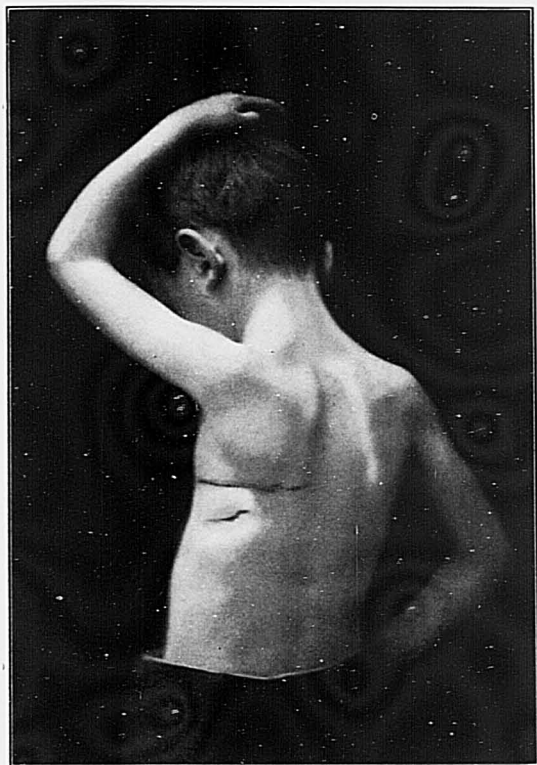


FIG. 7.—Exploratory incision line above the fistula.



FIG. 8.—Result after Schede operation.

the stalactite-shaped formations obtained from old fragments. The skiagraph (Fig. 5) illustrates similar formations two months after resection.

The development of these irregular masses deserves close consideration. Their shape is apt to injure the pleura, which teaches the necessity of methodical exercise at an early period, that is, of forcible inspiration as long as the area in question is soft and yielding; in other words, there is deposition of calcareous matter in the regenerating bone tissue.

As to the inflammatory irritation as an induction to this abundant osseous formation as well as to the inflammatory atrophy causing translucency of the ribs, I may refer to "The pathologic and therapeutic aspects of the effects of the Röntgen rays, *Medical Record*, January 18, 1902."

Schede's advice as to the outlining of the skin-flap has been modified by Helferich, Sudeck, and Tietze. In suitable cases these modifications yield good results. But none of them can be utilized as a general method.

As an illustration of the views expressed, the following cases may serve:

CASE I represents a boy of six and one-half years, who, as reported, took sick with pleuropneumonia in March, 1900. In April an incision was made, which was followed by great improvement. A fistula, however, remaining, rib resection was performed in May, 1901. But the lungs did not expand, nor did the chest wall collapse farther, so that on October 2, 1902, I resorted to thoracic resection, the seventh rib being resected first. After free access was gained to the cavity, the remnants of the eighth rib, which surrounded the fistulous tract, were removed. Then followed the exsection of a large portion of the fifth and sixth ribs, as they were overlying the cavity, and the removal of the lower area of the scapula together with the respective pleural areas.

The hæmorrhage was very moderate. No stimulations were necessary, and recovery took place without reaction.

The skiagraph (Fig. 5), taken two months after operation, shows the extent of the resection as well as the proliferation of

the rib stumps. Although there is a deep depression left, more than a year after recovery, there is no curvature, so that practically no deformity exists (Fig. 7).

CASE II represents a man of forty years, who was seized with pleuropneumonia in November, 1899. Aspiration was tried first; later, the purulent effusion was discharged by the incision method. The thickened pleura demanded repeated rib resections, altogether four thoracotomies being undertaken. Schede's operation was finally performed two years ago (Fig. 8). But, although this was done in the most skilful manner, the cavity did not become obliterated, that is to say, the portion of the cavity which could be covered by the horse-shoe flap became considerably diminished in its extent. So the surgeon obtained as much benefit from the method as it was able to grant. But there still remained an immense cavity above that area. When I saw the emaciated patient for the first time, operative exploration in the upper thoracic region revealed the presence of a large and irregular cavity which extended as far as the first rib anteriorly and to the second in the dorsal region. The anterior area was exposed first, the fibrous tissue being extensively and atypically removed in order to get better access to the cavity, so that the wound treatment could be done more effectively. The patient improved soon afterwards, so that his condition permitted of a more severe interference. The upper four ribs were then exsected after access was obtained by the pectoro-axillary incision described above. This resulted in considerable collapse of the anterior chest wall, which was gradually followed by the obliteration of that portion of the cavity (Fig. 9). Nine months ago the removal of the posterior rib portion, together with the lower part of the scapula, was undertaken. The cavity has now gradually filled up, the only defect being that the axillary region is not yet covered by skin. The patient's general condition is excellent. There is, of course, marked deformity in proportion to the enormous collapse of the chest wall. But the patient's attitude is straight, nevertheless (Fig. 10). I attribute this to continuous exercise. The skiagraph (Fig. 11) shows the anterior aspect of the cavity after the first exploratory operation, while Fig. 12 shows the rib defect at the posterior aspect. It is noteworthy that the bones show the sign of inflammatory atrophy, due to the absorption of calcareous matter, as an expression of which the poor contrast between bony and soft tissues must be regarded.



FIG. 9.—Result after superior thoracic resection.

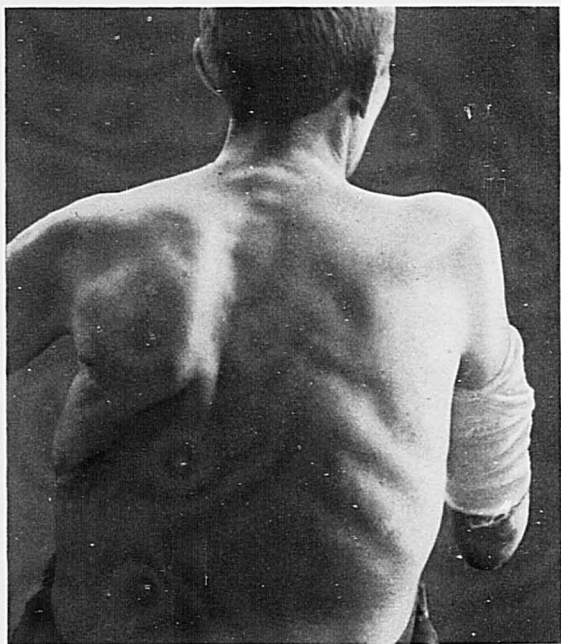


FIG. 10.—Final result (note small size of left thorax).



FIG. 11.—Anterior aspect of cavity.



FIG. 12.—Posterior aspect of cavity.